

TORNADO STRIKES SWIFTLY-MOVING TRAIN

By R. J. McCLURG

[Weather Bureau, Moorhead, Minn.]

The crack train, Empire Builder, Seattle, Wash., to Chicago, Ill., May 27, 1931, was struck by a tornado nearly at a right angle as it was speeding at nearly a mile a minute about 5 miles east of Moorhead, Minn. The locomotive weighing 136 tons and the tender 94 tons, remained on the track. The engineer reports the cab windows as being torn out and that his goggles were blown away. Mr. McClurg's report follows.—ED.

A destructive tornado passed over part of extreme western Minnesota May 27, 1931, beginning about 4:15 p. m. The funnel-shaped cloud was first seen by farmers in the north part of Kurtz township about 10 miles south-southeast of the Moorhead Weather Bureau Office. It traveled an east-northeasterly course from first observation, crossing the Great Northern Railway track one-half mile northwest of Ruthruff siding, where it wrecked "The Empire Builder" at about 4:30 p. m. No observer can be found that knows the exact time this storm struck the train. From this point onward it took a north-northeasterly course for about 40 miles, where it destroyed everything in its path when it touched the ground. At times it lifted from the ground for several miles, only to swoop down to the ground again and carry on its destructive work. It evidently blew itself out between Gary and Fertile, Minn. It seems to be impossible to find anyone who knows at what time it was last seen. But it must have been traveling very rapidly for everyone who saw it spoke about its rapid movement. The tornado never came nearer than 4 miles to the United States Weather Bureau station at Moorhead.

The morning weather map of May 27 shows that Moorhead lay in a trough of low pressure, the center of which was over southeastern South Dakota. At the Moorhead station the following atmospheric conditions were recorded:

The barograph showed the air pressure was very erratic from 1:30 a. m., with a reading of 28.74 inches, until 2:00 p. m. at which time the reading was 28.64 inches. The pressure then fell rapidly to 28.47 inches by 4:30 p. m., then remained almost constant to 5:15 p. m. It then rose rapidly until 5:30 p. m., after which the rise was more gradual. Light rain began to fall at 4:04 p. m. with a heavy downpour from 4:16 p. m. to 4:37 p. m. Soft hail fell with the rain for 6 minutes. The total precipitation was 0.31 inch. The sun shone intermittently from 4:41 for the remainder of the evening. The wind velocity was from 6 to 13 miles an hour from 4 p. m. to 5:16 p. m., and was recorded at least once from the eight points of the compass. From 5:12 p. m. a southwest wind was increasing steadily, when at 5:30 p. m. it suddenly shifted to the northwest and reached a velocity of 33 miles an hour for 5 minutes. One mile was recorded at the rate of 36 miles per hour. The wind decreased steadily after 5:35 p. m.

Despite the untold damage done by this tornado of gigantic power, the marvelous thing about it is that only two lives were lost. When one car of the famed "Empire Builder" with its 117 passengers was lifted from the rails and carried through the air to be laid in a ditch 80 feet away, one man was hurled through a window and crushed beneath the coach when it fell on him. The other death resulted when a farm youth was pinned beneath the wreckage of his home and crushed to death.

The greatest manifestation of the force of this storm was shown by the wrecking of the train. Without a doubt, five of the coaches were torn loose from the engine and lifted bodily from the rails, the farthest one being hurled 80 feet away. The remaining eight coaches were

probably pulled from the rails. The engine and tender remained on the rails intact. Fifty-seven passengers were injured by the impact and flying glass. It was due only to the fact that the heavy steel coaches were strong enough to resist the crash that more lives were not lost.

According to available reports, only 3 houses, 1 church, and 1 schoolhouse were demolished. The remainder of the damage was to other farm buildings, machinery, livestock, and trees.

On a tour of a portion of the path of the tornado the writer observed the usual freakish actions of the storm. At the Hatledal farm where one of the deaths took place the family are positive that two separate storms occurred. The first twister coming from the southwest destroyed the home, pinning Melvin Hatledal beneath a cement block in the southeast corner of the basement. After this twister passed on, the family escaped from the basement to the yard. In just a few minutes they observed a second twister, yellowish in color, approaching from the northwest. They expected it to strike them any second, but it veered to the east just before it reached them and wrecked a barn about 250 yards distant.

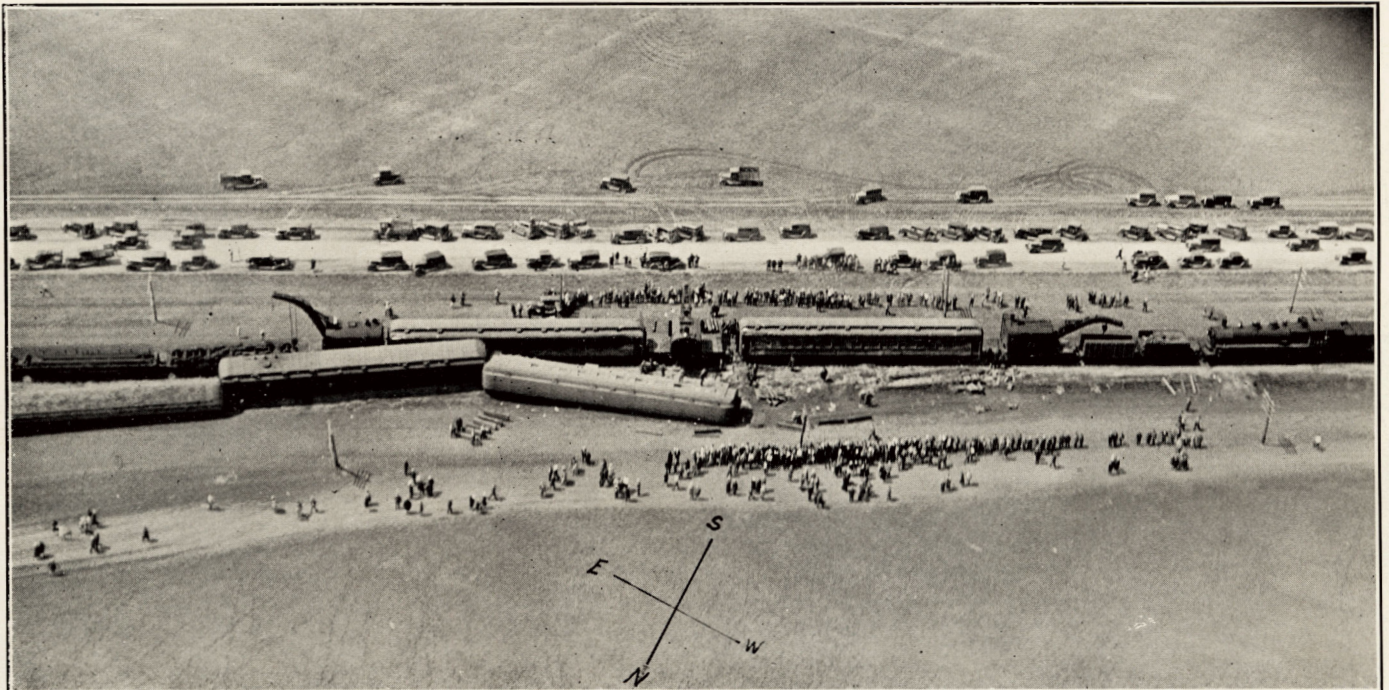
At the Fred Kudebeh farm a mile or so northwest of the Hatledal farm, Mr. Kudebeh was standing in his barn door watching the main twister passing about 200 yards to the east of him. All at once his own barn was lifted into the air leaving him standing unharmed. The barn was carried almost due west straight toward the farmhouse. One wall landed on the north side of the house, one wall on the south side, and one end on the east side of the house. The other end of the barn fell just a few feet west from the foundation. But the roof was carried over the house, through the tops of a grove of trees, some of which were 50 feet high, and fell in a field fully 200 yards from where the barn originally stood. Yet the house was not touched, except one corner of the porch which was struck by a flying timber.

The main twister traveling due north at the time struck the Hanson farm where absolutely everything was demolished. House, barns, machine sheds, farm implements, dead animals and poultry were scattered all over the countryside. Farm implements of heavy iron and steel were twisted beyond recognition. Thirteen almost featherless chickens remained from a flock of 300. Trees were denuded of their limbs and leaves. The wreckage was carried to the northwest, while at another farm only about 300 yards west, wreckage was carried to the southeast.

The writer saw straws driven into the bark of trees and at one place, saw a fresh straw driven in the wall of a house. At one place it was reported that a lace curtain was blown between the pane of glass and the sash with the glass remaining unbroken.

A conservative estimate of the damage was placed at \$200,000. Growing crops not damaged very much where the storm did the damage to buildings, but reports from the higher lands to the southeast, where the soil is lighter, state that many fields will be reseeded because the wind blew away the planted crops.

The smaller picture of the two (fig. 1) was taken a few hours after the storm from the end of the fourth coach from the rear of the train. Eight coaches between the coach in the front of the picture and the engine in the background are lying in a ditch to the left of the picture. The aerial view was taken after the wrecker had placed two of the coaches back on the track.



Photos furnished through courtesy of Mr. Hooper, City Editor, Fargo Forum

FIGURE 1.—Upper, taken from end of fourth coach from rear of train; eight coaches are lying in a ditch to the left; lower, an aerial view of the wrecked cars after the wrecker had put two cars back on track

SUPPLEMENTAL REPORT BY R. J. M'CLURG

I had a conversation with the engineer, Mr. McKee, and the fireman, Mr. Klinfihn, these men gave an account of their observation of the tornado.

Mr. Klinfihn observed the storm at a distance, but did not see the funnel cloud. At the time the train was struck, he was busy at his work firing and was completely unaware of the impending disaster.

Mr. McKee, the engineer, first noticed the storm a mile or so away in the southwest, but did not see a funnel at that time. The train was traveling toward the southeast. He had seen many worse looking storms and did not give it much attention at first. The storm did not seem to move at all for several minutes, then moved slowly toward the train until it was about one-half mile away. It was then he noticed the funnel cloud and saw it take the top off a straw stack. The twister then darted forward and before he realized it was coming it had struck the train at almost right angles.

Mr. McKee thought the full force of the storm struck the engine; but due to the immense weight of the engine and the round shape, the engine and loaded tender were left standing on the rails. The remainder of the train of 12 coaches was derailed. Mr. McKee's glasses were pulled from his face by a force that he described as "a suction at his body." The fact that the coupling between

the engine and the mail car was unbroken and still closed and locked after the wreck indicates that the front end of the mail car was lifted directly upward, permitting the coupling to separate without breaking. All the 12 cars remained coupled to each other, but some of the couplings were badly twisted by the derailment. All but one of the cars fell on their sides. This one exception was a car caught between two coaches and could not fall over. On page 2 of my report of June 2, 1931, I stated that five coaches were lifted from the tracks and the other 8 were pulled from it. It should read "Five coaches were lifted from the tracks and the other 7 were pulled from the track."

The conductor stated that practically all of the windows of the coaches were closed because a light rain was falling; the car ventilators were open. The greater number of the windows were not broken by the sudden lessening of the outside pressure. They had to be broken by trainmen and others to let the imprisoned passengers escape.

The following is a list of the weights of the cars and engine:

	Tons		Tons
Engine.....	136	Diner.....	89
Tender, loaded.....	94	Pullman.....	64
Mail car.....	70	Do.....	64
Baggage car.....	72	Do.....	64
Smoking car.....	59	Do.....	64
Day coach.....	83	Do.....	61
Tourist.....	76	Club car.....	85

TABLE FOR FACILITATING COMPUTATION OF POTENTIAL TEMPERATURE

By J. C. BALLARD

[Aerological Division, Weather Bureau, Washington, D. C.]

The following table of factors has been found to be very useful in the computation of potential temperatures. Where P = pressure in millibars, the table gives values $K = \left(\frac{1000}{P}\right)^{0.288}$ for intervals of one millibar from 1,049 to 40 millibars of pressure. For lower pressure the computation must be made by logarithms.

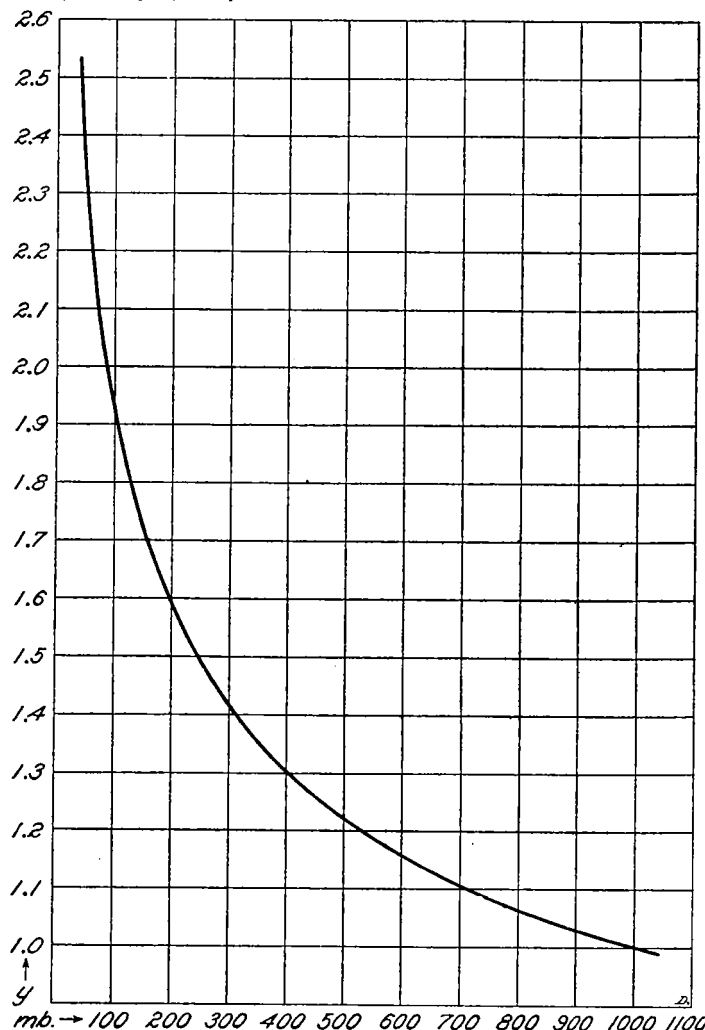
The factor $\left(\frac{1000}{P}\right)^{0.288}$ is the pressure factor in the formula

$$\theta = T \left(\frac{1000}{P}\right)^{0.288}$$

Where θ = potential temperature in °A, T = actual temperature in °A and P = pressure in millibars. Hence, it is evident that the potential temperature is computed merely by multiplying the actual temperature in °A by the proper factor (K) found in the table.

Computations have been made for whole millibars, and where pressure is used to tenths of millibars, linear interpolation for tenths has been found to be sufficiently accurate for ordinary purposes. Several cases have been tested for error in the factor due to linear interpolation and in no case has an error as much as 0.0003 been found. An error of 0.0003 in the factor would never produce an error of more than 0.1° in potential temperature, or one well within the range of accuracy of the observed temperature and pressure. The accompanying graph (fig. 1) is the curve $Y = \left(\frac{1000}{P}\right)^{0.288}$. It is apparent that for low pressures where differences in the values of the function are relatively great for small differences in pressure, the error due to interpolating linearly between two pressures for intermediate values of the function would be relatively small.

If it is desired, tables of interpolated parts can be prepared which will assist somewhat in the interpolation.¹

FIGURE 1.—Graph of the curve $Y = \left(\frac{1000}{P}\right)^{0.288}$

¹ Such tables are available in Publication No. 245 of the Carnegie Institution, 1918, by H. B. Hedrick.